

Digital Transformation and Energy Security as Complementary Mechanisms
of EU–Ukraine Integration in Central and Eastern Europe

Denys Tibeikin

Bachelor's Student in Philology (Germanic Languages and Literatures,
including Translation), with English as the First Foreign Language
Mariupol State University, Kyiv, Ukraine

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Abstract

Ukraine's European integration increasingly operates through digital and energy systems that connect Ukrainian institutions and infrastructure with European standards and networks. This paper examines these processes through four dimensions of integration: legal and regulatory, institutional and administrative, infrastructural and market, and regional operational cooperation. It uses structured qualitative policy analysis with process-tracing elements and selected quantitative indicators, drawing on EU and Ukrainian institutional documents, Energy Community assessments, international reports, and academic studies available up to 20 June 2026. The evidence is strongest for digital public services, interoperability, cybersecurity cooperation, electricity-system synchronisation, cross-border exchange capacity, and regulatory approximation. The digital–energy relationship is best described as functional complementarity: digital systems support increasingly decentralised and interconnected energy infrastructure, while reliable electricity underpins digital public services and critical infrastructure. The paper does not identify an independent causal “synergy effect”. Regional evidence is strongest in electricity coordination and in differentiated cooperation with Poland and Romania.

The study uses a structured qualitative policy analysis with process-tracing elements and selected quantitative indicators. The documentary and statistical review covers materials available up to 20 June 2026. Evidence is assessed by identifying an observable implication for each mechanism, comparing baseline and latest values where data permit, and incorporating counterevidence from independent or critical institutional sources. The design is not intended to estimate causal effects; rather, it tests whether the proposed mechanisms are supported by documented institutional, technical, and operational developments.

The analysis finds that digital transformation contributes most clearly through digital public services, interoperability, cybersecurity capacity, and administrative approximation, while energy integration is most clearly demonstrated by electricity-system synchronisation, cross-border exchange capacity, and continuing alignment with EU energy-market rules. The evidence for the digital–energy relationship is more limited: Ukrainian and European sources document mutual infrastructural dependence and operational requirements, but do not establish a measurable additional integration effect. The paper therefore treats “functional complementarity” as a mechanism of coordination rather than as a causal synergy.

The Central and Eastern European dimension is examined through focused cases of Poland and Romania, supplemented by the multilateral electricity-capacity coordination involving Hungary, Moldova, Poland, Romania, Slovakia, and Ukraine. These cases show where regional cooperation is directly documented and where the evidence remains limited.

Keywords: Ukraine; European Union; digital transformation; energy security; European integration; Central and Eastern Europe; digital governance; renewable energy; resilience; regional cooperation.

Introduction

The relationship between Ukraine and the European Union has entered a more formal phase since 2022. Ukraine applied for EU membership on 28 February 2022, received candidate status on 23 June 2022, and formally opened accession negotiations on 25 June 2024. These milestones should be distinguished from broader forms of functional connectivity, such as participation in EU programmes, technical interoperability, and infrastructure interconnection. The paper therefore uses “European integration” as an umbrella term only when it specifies which of these dimensions is being observed.

Two dimensions are particularly important in this process: digitalisation and energy security. Digital reforms affect public-service delivery, administrative interoperability, cybersecurity, and the implementation of European digital standards, while energy reforms concern electricity-market integration, infrastructure resilience, renewable-energy deployment, and cross-border connectivity. Their interaction is most visible at the level of critical infrastructure: increasingly digital electricity systems require data, monitoring, forecasting, and secure communications, while digital public services and telecommunications depend on reliable electricity supply.

Against this background, the paper asks: **How do digital transformation and energy-sector modernisation support Ukraine’s European integration, and through which mechanisms do these processes interact with regional cooperation and resilience in Central and Eastern Europe?**

The analytical procedure follows four steps. First, “European integration” is operationalised as: (1) legal and regulatory integration, measured through approximation or implementation of EU rules; (2) institutional and administrative integration, measured through interoperable institutions and participation in European programmes; (3) infrastructural and market integration, measured through physical interconnection, cross-border capacity, and actual market-access arrangements; and (4) regional operational cooperation, measured through joint cross-border procedures or institutions. Second, the two independent domains are operationalised through observable outputs: digital-service adoption, registry interoperability, cybersecurity cooperation, grid synchronisation, electricity trade capacity, distributed-energy deployment, and infrastructure-restoration indicators. Third, each proposed mechanism is evaluated against an observable implication and, where available, a baseline or counterevidence. Fourth, conflicting or cautionary evidence is retained rather than treated as an anomaly. The source set prioritises official statistical and regulatory data, EU and Ukrainian institutional documents, Energy Community assessments, international analytical reports, and peer-reviewed academic studies. Poland and Romania were selected purposively because both are neighbouring EU member states with documented, distinct roles in Ukraine-related energy, digital, security, logistics, or reconstruction cooperation. This protocol is closer to structured qualitative policy analysis with process-tracing elements than to a causal econometric design.

The evidence base remains institutionally concentrated. EU institutions, Ukrainian authorities, international organisations, and transmission-system or sector regulators produce much of the available data, and these actors have incentives to emphasise programme outputs. To mitigate this limitation, the revised analysis incorporates critical Energy Community assessments, independent academic studies, and explicit baseline/latest comparisons. The study still does not employ a counterfactual capable of isolating the causal effect of digital or energy reform on accession, resilience, investment, or trust.

The paper's contribution lies in connecting two transformation processes through observable forms of convergence rather than claiming a causal multiplier. Its central analytical proposition is that digital and energy systems increasingly share requirements for interoperability, secure data exchange, operational continuity, infrastructure protection, and regulatory coordination. The strength of this proposition is therefore assessed by the extent to which these requirements are documented in Ukrainian and regional practice.

1. Digital Transformation and European Integration

1.1 Digital Governance and Institutional Modernisation

Ukraine's digital transformation has become an important component of institutional modernisation and European integration. Initially focused on improving administrative efficiency and access to public services, digitalisation has increasingly expanded into areas of interoperability, cybersecurity, administrative transparency, and regulatory approximation.¹ Since 2022, these functions have acquired additional importance because digital infrastructure has helped maintain the continuity of public administration under wartime conditions.²

A central element of this transformation is the Diia ecosystem. In March 2026, the Ministry of Digital Transformation reported 24 million application users. By April 2026, the Diia portal had more than 7 million users and offered more than 170 services. These figures should be treated separately: application users, portal users, and service counts describe different layers of the ecosystem. The scale of adoption is therefore evidence of domestic administrative digitalisation, but by itself it does not demonstrate cross-border European interoperability.³

Interoperability represents a second important dimension. The Trembita system enables secure information exchange among government registries and supports the principle that citizens should not repeatedly submit information already held by public authorities. Its continued development is relevant to European integration because administrative compatibility depends not only on legislation but also on the technical and organisational ability of institutions to exchange and process information through compatible standards.

European cooperation has supported this process through programmes addressing digital public services, interoperability, cybersecurity, regulatory approximation, and digital infrastructure. The paper identifies DT4UA, EU4Digital, Trembita 2.0, the Digital Europe Programme, and European cybersecurity cooperation among the principal initiatives in this area.⁴ Their relevance to integration

European Commission, Supporting Ukraine through Digital (2024).; European Commission, Ukraine Report 2024.; Ministry of Digital Transformation of Ukraine, Strategy for the Digital Development of Innovations in Ukraine until 2030.; OECD, Digitalisation for Recovery in Ukraine (2024).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; OECD, Digitalisation for Recovery in Ukraine (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).

Ministry of Digital Transformation of Ukraine, "Вже 24 мільйони українців обрали Дію" (16 March 2026).; Ministry of Digital Transformation of Ukraine, "7 мільйонів українців отримують державні послуги онлайн на порталі Дія" (30 April 2026).

European Commission, Supporting Ukraine through Digital (2024).; European Commission, The Digital Europe Programme (2025).; Ministry of Digital Transformation of Ukraine, Strategy for the Digital Development of Innovations in Ukraine until 2030.; Ministry of Digital Transformation of Ukraine, White Paper on Artificial Intelligence Regulation in Ukraine.; European Commission, "EU and

lies primarily in strengthening institutional and technical compatibility rather than simply providing technological equipment.⁵

The wartime environment has further exposed the importance of digital resilience. Cyberattacks, physical infrastructure damage, and the need to maintain public services under exceptional conditions have increased the importance of secure digital infrastructure, backup capacity, distributed systems, and incident-response mechanisms.⁶ Ukrainian institutions have consequently accumulated practical experience in maintaining digital public administration under wartime conditions, while European partners have provided technological, financial, and regulatory support.⁷ This interaction also creates opportunities for reciprocal exchange of expertise rather than a purely one-directional transfer of European knowledge.⁸

Several constraints remain relevant to the sustainability of this transformation. Cybersecurity threats, unequal digital literacy, regional disparities in connectivity, and damage to physical infrastructure can limit access to digital services.⁹ At the same time, technological development requires continued adaptation of legislation concerning areas such as artificial intelligence, data protection, cybersecurity, and digital identity.¹⁰ These constraints indicate that digitalisation should be assessed not only through the expansion of services but also through the resilience and institutional capacity required to sustain them.

Table 1. Selected empirical indicators relevant to European integration

Indicator	Baseline	Latest observation	Interpretation / limitation
EU accession process	Candidate status: 23 Jun 2022	Accession negotiations opened: 25 Jun 2024; first cluster opened: 15 Jun 2026	Formal accession-related integration; does not measure sector performance

Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue” (2025).; Ministry of Digital Transformation of Ukraine, Diia figures; 8 October 2025 source on 23+ million users.

European Commission, Supporting Ukraine through Digital (2024).; European Commission, The Digital Europe Programme (2025).; Regulation (EU) 2024/792 establishing the Ukraine Facility.

IEA, Ukraine’s Energy Security and the Coming Winter (2024).; OECD, Digitalisation for Recovery in Ukraine (2024).; OECD, Enhancing Resilience by Boosting Digital Business Transformation in Ukraine (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).; European Commission, “EU and Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue” (2025).

European Commission, Supporting Ukraine through Digital (2024).; European Commission, The Digital Europe Programme (2025).; UNDP, Digital Transformation and Recovery in Ukraine (2024).; European Commission, “EU and Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue” (2025).

European Commission, “EU and Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue” (2025).

IEA, Ukraine’s Energy Security and the Coming Winter (2024).; OECD, Digitalisation for Recovery in Ukraine (2024).; OECD, Enhancing Resilience by Boosting Digital Business Transformation in Ukraine (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).

Ministry of Digital Transformation of Ukraine, Strategy for the Digital Development of Innovations in Ukraine until 2030.; Ministry of Digital Transformation of Ukraine, White Paper on Artificial Intelligence Regulation in Ukraine.

Indicator	Baseline	Latest observation	Interpretation / limitation
Diia application / portal	21+ million app users (Oct 2024)	24 million app users (Mar 2026); 7 million portal users and 170+ portal services (Apr 2026)	Domestic administrative digitalisation; user scale is not itself cross-border interoperability
Electricity exchange capacity	100 MW initial commercial capacity (Jun 2022)	1,700 MW EU→Ukraine–Moldova block and 650 MW reverse capacity (Jun 2025)	Concrete infrastructural/market integration indicator; capacity is not equal to actual traded volume
Dispatchable power capacity	≈38 GW before full-scale invasion	≈12 GW after spring 2024 attacks; ≈3 GW restored by end-2024	Shows wartime destruction and partial recovery; not a pure digital/renewable effect
Reconstruction needs	\$524 billion estimated in RDNA4 (Feb 2025)	Nearly \$588 billion in RDNA5 (Feb 2026); energy damage up ≈21% vs RDNA4	Context indicator for resilience and reconstruction pressure, not an integration outcome

Source: compiled from European Commission, Ministry of Digital Transformation, ENTSO-E, IEA and World Bank materials.¹¹

European Commission, Ukraine's Path towards EU Accession (current timeline, 2026).; Ministry of Digital Transformation of Ukraine, "Вже 24 мільйони українців обрали Дію" (16 March 2026).; Ministry of Digital Transformation of Ukraine, "7 мільйонів українців отримують державні послуги онлайн на порталі Дія" (30 April 2026).; ENTSO-E, "Commercial Exchanges of Electricity with Ukraine/Moldova to Start on 30 June" (28 June 2022).; ENTSO-E, "TSOs Launch New Process to Calculate Net Transfer Capacity at the Borders of Ukraine and Moldova" (18 June 2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).; World Bank, "Updated Ukraine Recovery and Reconstruction Needs Assessment Released" (23 February 2026).

2. Energy Security and European Integration

2.1. Energy Integration Between Ukraine and the European Union

Energy cooperation has become a central component of Ukraine–EU relations, particularly since 2022. The full-scale Russian invasion accelerated a shift towards electricity-market integration, infrastructure resilience, diversification, and regulatory approximation, while the EU has increasingly linked Ukraine’s energy cooperation with the broader objective of integration into the European energy market.¹² This transformation has affected both Ukraine’s position within European energy networks and the institutional framework governing its energy sector.¹³

A decisive development was the synchronisation of Ukraine’s electricity system with the Continental European Synchronous Area (ENTSO-E) on 16 March 2022. The process was accelerated after Russia’s full-scale invasion and was completed in less than three weeks, although more than one year had initially been envisaged.¹⁴ Synchronisation created the technical basis for subsequent cross-border electricity exchange and was made permanent on 28 November 2023.¹⁵

The significance of ENTSO-E integration lies primarily in the additional flexibility it provides to the electricity system. Interconnection allows electricity to flow across national borders subject to system and market conditions, creating possibilities for imports during periods of domestic shortage and exports when available generation exceeds domestic demand.¹⁶ This mechanism does not eliminate Ukraine’s vulnerability to generation and transmission losses, but it provides an additional channel through which electricity supply can be balanced during disruptions.¹⁷

The same development has a regional dimension. Ukraine’s electricity system is now interconnected with neighbouring European systems, making cross-border electricity exchange part of

Energy Community Secretariat, “Ukraine Advances Electricity Market Integration with the European Union” (2026).; European Commission, Ukraine Report 2024.; IEA, Ukraine’s Energy Security and the Coming Winter (2024).; IEA, Ukraine’s Energy Security (2025).; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.

Energy Community Secretariat, “Ukraine Pushes EU Energy Reforms and Interconnections” (2025).; Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, “Ukraine Advances Electricity Market Integration with the European Union” (2026).

European Commission, “2 Years Since Ukraine and Moldova Synchronised Electricity Grids with EU” (2024).

European Commission, “2 Years Since Ukraine and Moldova Synchronised Electricity Grids with EU” (2024).

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, “Ukraine Advances Electricity Market Integration with the European Union” (2026).; IEA, Ukraine’s Energy Security and the Coming Winter (2024).

IEA, Ukraine’s Energy Security and the Coming Winter (2024).; IEA, Ukraine’s Energy Security (2025).

the broader regional energy architecture.¹⁸ The Energy Community identifies electricity-market integration and interconnection with the EU as continuing elements of Ukraine's energy reform process.¹⁹ The strategic significance of this integration therefore lies not simply in physical interconnection but in the gradual incorporation of Ukraine into European market and regulatory arrangements.²⁰

Energy integration has also acquired greater significance following the EU's efforts to reduce dependence on Russian fossil fuels. The REPowerEU framework links energy security with energy savings, diversification of energy supplies, and the production of clean energy.²¹ Ukraine's integration into European energy networks creates potential for cooperation in electricity trade, renewable generation, infrastructure development, and other emerging energy markets.²² These opportunities should nevertheless be distinguished from outcomes that have already been achieved: electricity interconnection is an established development, whereas areas such as hydrogen cooperation remain largely prospective.²³

The wartime destruction of generation and transmission infrastructure has also changed the practical meaning of energy security. Attacks have affected generation facilities, substations, transmission infrastructure, and other critical energy assets, creating significant risks for electricity supply and the operation of essential services.²⁴ Electricity availability affects not only households and industrial production but also hospitals, water systems, telecommunications, transport, and digital public administration.²⁵ Energy security in Ukraine therefore increasingly concerns the ability of the system to maintain or restore essential services following physical or technical disruption.²⁶

Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).; EBRD, "Supporting Ukraine's Private Renewable Energy Industry" (2024).

Energy Community Secretariat, "Ukraine Pushes EU Energy Reforms and Interconnections" (2025).; Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).

European Commission, REPowerEU Plan (2022).

Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).; European Commission, Ukraine Report 2024.; IEA, Renewables 2024.; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.

Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Ukraine's Energy Security (2025).; World Bank, Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5) (2026).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Ukraine's Energy Security (2025).

EU–Ukraine energy cooperation also has an important regulatory dimension. Participation in the European internal energy market requires more than physical grid connection. It involves market rules, technical standards, institutional capacity, and regulatory approximation.²⁷ The Energy Community’s reporting identifies continued Ukrainian progress towards EU energy reforms and electricity-market integration, although full market coupling remains dependent on further legal and institutional reforms.²⁸ Regulatory convergence is therefore an important complement to infrastructure integration.

Ukraine’s underground gas storage infrastructure represents another potential element of regional interdependence. Ukraine has the second-largest gas-storage capacity in Europe after Russia, with approximately 30.9 bcm of working capacity across 13 underground storage facilities.²⁹ This infrastructure creates opportunities for seasonal storage and cooperation with European gas markets.³⁰ However, its strategic contribution depends on market conditions, infrastructure connectivity, regulatory arrangements, security risks, and the broader evolution of European gas demand.³¹ It is therefore more appropriate to treat Ukrainian storage as a regional strategic asset with potential rather than as an automatically realised contribution to European energy security.

Table 2. Main components of Ukraine–EU energy integration

Component	Current development	Strategic significance
ENTSO-E synchronisation	Synchronisation with the Continental Europe Synchronous Area	Technical interconnection and access to cross-border electricity exchange
Electricity trade	Cross-border electricity imports and exports	Additional flexibility during changes in domestic supply and demand
Gas storage	Large underground storage network linked to European markets	Potential regional and seasonal storage function
Renewable energy	Distributed solar and wind deployment; reconstruction-oriented decentralisation	Diversification of generation and decarbonisation potential
Legislative approximation	Alignment of Ukrainian energy regulation with EU frameworks	Institutional and regulatory convergence
Critical infrastructure protection	Protection and modernisation of generation and transmission assets	Energy-system resilience under wartime conditions

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, “Ukraine Advances Electricity Market Integration with the European Union” (2026).

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, “Ukraine Advances Electricity Market Integration with the European Union” (2026).

IEA, Ukraine Energy Profile; gas-storage capacity and system overview.

IEA, Ukraine’s Energy Security and the Coming Winter (2024).; IEA, Ukraine Energy Profile; gas-storage capacity and system overview.

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; IEA, Ukraine’s Energy Security and the Coming Winter (2024).; IEA, Ukraine’s Energy Security (2025).

Source: compiled by the author based on Energy Community Secretariat, International Energy Agency, European Commission, and Ministry of Energy of Ukraine materials listed in the References.³²

2.2. Renewable Energy Development as a Foundation of Energy Resilience

The development of renewable energy has acquired a strategic dimension in Ukraine since the beginning of the full-scale Russian invasion. Before 2022, renewable-energy policy was primarily associated with decarbonisation, environmental objectives, and the gradual alignment of Ukraine's energy sector with European climate policy.³³ Wartime disruptions have expanded this agenda by linking renewable generation to energy-system diversification and the protection of essential services.³⁴ However, the contribution of renewables to resilience depends on their integration with storage, grid management, balancing capacity, and physical infrastructure.³⁵

The vulnerability of Ukraine's centralised electricity system became particularly evident through repeated attacks on generation and transmission infrastructure.³⁶ Damage to large generation facilities or substations can affect electricity supply over relatively large areas. Distributed generation offers an alternative configuration in which electricity production is geographically dispersed across multiple installations.³⁷ In principle, this can reduce the consequences of the failure of any single generating asset. The resilience benefit therefore derives primarily from diversification and decentralisation, rather than from the renewable character of the technology itself.³⁸

Energy Community Secretariat, "Ukraine Pushes EU Energy Reforms and Interconnections" (2025).; Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; Energy Community Secretariat, "Ukraine Advances Electricity Market Integration with the European Union" (2026).; IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Ukraine's Energy Security (2025).; IEA, Ukraine Energy Profile; gas-storage capacity and system overview.; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.; European Commission, "2 Years Since Ukraine and Moldova Synchronised Electricity Grids with EU" (2024).; ENTSO-E, "TSOs Launch New Process to Calculate Net Transfer Capacity at the Borders of Ukraine and Moldova" (18 June 2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Renewables 2024.; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.; European Commission, The European Green Deal (2019).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Ukraine's Energy Security (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Ukraine's Energy Security (2025).; World Bank, Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5) (2026).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

This limitation is important for assessing the resilience argument. Solar and wind generation are variable resources: electricity output depends on weather and time conditions and therefore cannot independently guarantee continuous supply.³⁹ Increasing their share in the electricity mix consequently creates additional requirements for energy storage, flexible generation, demand management, forecasting, and transmission capacity.⁴⁰ These requirements do not undermine the strategic value of renewable energy, but they demonstrate that decentralised generation should be treated as one element of a resilient energy system rather than as a substitute for conventional generation and grid infrastructure.⁴¹

The wartime environment introduces an additional constraint. Distributed generation can reduce the consequences of damage to individual large power plants, but renewable installations remain vulnerable to physical destruction, supply-chain disruptions, cyberattacks, and damage to transmission and distribution infrastructure.⁴² Decentralisation therefore reduces concentration risk but does not remove infrastructure vulnerability. This distinction is particularly important for Ukraine, where resilience depends not only on the number of generating units but also on the ability to maintain distribution networks and restore damaged infrastructure.⁴³

European energy policy provides an additional institutional framework for this transition. The EU's European Green Deal and REPowerEU strategies link renewable-energy deployment with decarbonisation, energy efficiency, diversification of energy supplies, and reduced dependence on imported fossil fuels.⁴⁴ Ukraine's renewable-energy development is therefore relevant to European integration not simply because it increases domestic electricity generation, but because it can support gradual convergence with European energy and climate policy.⁴⁵ This contribution is particularly

IEA, Renewables 2024.; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).

IEA, Renewables 2024.; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Ukraine's Energy Security (2025).; World Bank, Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5) (2026).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Ukraine's Energy Security and the Coming Winter (2024).; IEA, Ukraine's Energy Security (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

European Commission, The European Green Deal (2019).; European Commission, REPowerEU Plan (2022).

IEA, Renewables 2024.; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.; European Commission, The European Green Deal (2019).; European Commission, REPowerEU Plan (2022).

significant where renewable projects are accompanied by compatible market rules, grid infrastructure, and regulatory standards.⁴⁶

The interaction between renewable energy and digitalisation provides another relevant mechanism. Distributed electricity systems require increasingly sophisticated monitoring, forecasting, metering, demand management, and grid-control technologies.⁴⁷ Digital systems can therefore facilitate the coordination of geographically dispersed generators and consumers. Conversely, the expansion of distributed generation increases the need for digital management of electricity flows.⁴⁸ This constitutes a functional complementarity between digital and energy infrastructure, but it should not by itself be interpreted as evidence of a causal “synergy” producing an additional integration effect. Establishing such an effect would require comparative evidence beyond the scope of the present study.

Renewable energy also has potential implications for regional electricity cooperation. As Ukraine and neighbouring Central and Eastern European countries increase the share of variable renewable generation, cross-border interconnections can provide additional opportunities for balancing differences in production and demand.⁴⁹ However, greater renewable penetration can also increase pressure on transmission networks and balancing systems.⁵⁰ Regional interconnection should therefore be understood as both an opportunity and an infrastructural requirement for managing increasingly variable electricity production.

Energy Community Secretariat, Q1 2026 Report of Ukraine Energy Market Observatory.; IEA, Renewables 2024.; Ministry of Energy of Ukraine, Energy Strategy of Ukraine until 2050.

European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

IEA, Renewables 2024.; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

IEA, Renewables 2024.; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).

3. Digital–Energy Interdependence and Regional Cooperation

3.1. The Interdependence of Digitalisation and Energy Modernisation

The evidence presented in Sections 1 and 2 indicates that digital transformation and energy modernisation are increasingly interdependent components of Ukraine’s European integration. Modern electricity systems rely on digital monitoring, forecasting, data exchange, automated management, and cybersecurity, while digital public administration, telecommunications, and other critical digital services depend on reliable electricity infrastructure.⁵¹ The European Commission identifies digitalisation and data exchange as key enablers of a modern and resilient energy system, linking them to energy-system integration, flexibility, decarbonisation, and cybersecurity.⁵²

Ukraine’s wartime experience makes this interdependence more concrete. The IEA’s decentralised-energy roadmap states that a decentralised power system requires asset visibility, monitoring, advanced metering, and data infrastructure so that low-voltage networks and distributed energy resources can be supervised and controlled. This is a direct operational link between digital capability and energy modernisation rather than only a generic statement that “energy needs data”. On the reverse side, the destruction of energy assets has increased the need for backup and distributed power at hospitals, municipal facilities, and other essential services. These cases support functional complementarity, but they do not demonstrate that the joint effect on European integration is larger than the separate effects of the two domains.

The same relationship operates in the opposite direction. Digital public services, telecommunications, data centres, and electronic government systems require continuous electricity supply.⁵³ The interaction between the two sectors consequently has direct relevance to reconstruction and European integration, where interoperable infrastructure, compatible technical standards, regulatory coordination, and cybersecurity increasingly determine the practical capacity of institutions to operate within European networks.⁵⁴

OECD, Digitalisation for Recovery in Ukraine (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).; European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

OECD, Digitalisation for Recovery in Ukraine (2024).; UNDP, Digital Transformation and Recovery in Ukraine (2024).

European Commission, Supporting Ukraine through Digital (2024).; European Commission, The Digital Europe Programme (2025).; OECD, Digitalisation for Recovery in Ukraine (2024).; European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.; European Commission, “EU and Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue” (2025).

The available evidence therefore supports a narrower conclusion. Digital and energy transformation should not be treated as completely independent policy areas because each increasingly depends on infrastructure and institutional conditions created by the other.⁵⁵ At the same time, the study does not establish that their interaction produces an additional measurable integration effect beyond their separate contributions. Its strongest empirical implication is that coordinated development of the two domains can facilitate interoperability and reduce fragmentation between increasingly interconnected technological and energy infrastructures.⁵⁶

3.2. Regional Cooperation in Central and Eastern Europe: Ukraine as an Emerging Strategic Partner

The Central and Eastern European dimension is observable most clearly where neighbouring EU states have documented operational links with Ukraine. Poland and Romania are treated as focused cases because their cooperation spans more than one sector. Poland's record includes energy support and planned electricity exports, bilateral cybersecurity cooperation, satellite connectivity support, and cooperation linked to Ukraine's EU accession. Romania signed an agreement with Ukraine on electronic communications, digitalisation and cybersecurity and has also participated in trilateral coordination with Moldova and Ukraine on energy security, cross-border cooperation, logistics, and cybersecurity.⁵⁷

Energy integration provides the clearest regional mechanism. Ukraine's synchronisation with the Continental Europe Synchronous Area created the basis for cross-border electricity exchange. In June 2025, ENTSO-E reported a common process among transmission-system operators in Hungary, Moldova, Poland, Romania, Slovakia, and Ukraine for calculating commercial exchange capacity at the relevant borders. This is stronger evidence of regional operational cooperation than broad claims about "regional resilience" because it identifies a concrete common procedure and participating institutions.

Digital cooperation is more clearly demonstrated through bilateral and programme-based arrangements than through a single regional digital market. Poland and Ukraine have maintained

European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

European Commission, Supporting Ukraine through Digital (2024).; European Commission, The Digital Europe Programme (2025).; European Commission, Digitalising the Energy System – EU Action Plan, COM(2022) 552 final.

Ministry of Digitalisation of Poland, "Polska i Ukraina wzmacniają współpracę cyfrową" (25 March 2025).; Ministry of Climate and Environment of Poland, "Polsko-ukraińskie rozmowy o bezpieczeństwie energetycznym" (13 February 2025).; Ministry of Research, Innovation and Digitalisation of Romania, agreement with Ukraine on electronic communications, digitalisation and cybersecurity (5 January 2024).; European Commission, Ukraine Report 2025; Poland and Romania regional cooperation passages.

cooperation on cybersecurity, telecommunications, and technological support; Romania and Ukraine established cooperation on electronic communications, digitalisation, cybersecurity, cloud infrastructure for public services, and policy exchange. These developments show practical institutional connectivity, but the evidence does not justify claiming that a fully integrated regional digital governance space has already emerged.⁵⁸

Transport and reconstruction form a third regional channel. Poland has functioned as a major logistical hub and has supported Ukraine through energy, humanitarian, technical, and reconstruction-related assistance, while Romania has facilitated Ukrainian exports through EU solidarity lanes and participated in regional logistical and security coordination. The evidence therefore supports a differentiated regional role: electricity integration is the most operationally measurable; digital and reconstruction cooperation are documented but more difficult to quantify in terms of integration outcomes.⁵⁹

Ministry of Digitalisation of Poland, “Polska i Ukraina wzmacniają współpracę cyfrową” (25 March 2025).; Ministry of Research, Innovation and Digitalisation of Romania, agreement with Ukraine on electronic communications, digitalisation and cybersecurity (5 January 2024).; European Commission, Ukraine Report 2025; Poland and Romania regional cooperation passages.

European Commission, Ukraine Report 2025; Poland and Romania regional cooperation passages.

Conclusions

The digital evidence is strongest at the level of administrative capacity and interoperability. Diia reached 24 million application users by March 2026, while the portal had more than 7 million users and 170+ services by April 2026. These figures demonstrate extensive domestic uptake, but the relevant integration mechanism is not the number of users itself; it is the institutional compatibility, interoperability, and cybersecurity capacity associated with the digital systems.⁶⁰

Energy integration provides the clearest quantitative evidence. Commercial exchange capacity increased from the initial 100 MW in June 2022 to 1,700 MW for EU-to-Ukraine–Moldova flows and 650 MW in the reverse direction by June 2025. At the same time, Ukraine’s dispatchable capacity fell from roughly 38 GW before the full-scale invasion to 12 GW after the spring 2024 attacks, with about 3 GW restored by the end of 2024. These figures show why integration and resilience must be analysed together: cross-border capacity expanded while domestic generation remained severely damaged.⁶¹

The digital–energy relationship is best characterised as functional complementarity. IEA analysis shows that decentralised power systems require asset registries, advanced metering, monitoring, and control, while wartime energy disruptions simultaneously threaten the continuity of digital services. The evidence therefore establishes reciprocal operational dependence, not a measurable “synergy effect” on European integration.⁶²

The regional evidence is strongest for operational electricity coordination and is increasingly concrete for Poland and Romania. Poland’s digital, cyber and energy-support links with Ukraine and Romania’s digital-security agreement and trilateral regional cooperation demonstrate differentiated regional roles. The cases justify retaining the Central and Eastern European framing, but the paper does not claim that all dimensions of regional integration are equally developed or equally measurable.

The principal limitations remain the absence of a counterfactual, the concentration of evidence in institutional sources, and the short observation period for many reforms. In addition, several indicators—especially digital-service uptake and cross-border capacity—measure outputs or potential

Ministry of Digital Transformation of Ukraine, “Вже 24 мільйони українців обрали Дію” (16 March 2026).; Ministry of Digital Transformation of Ukraine, “7 мільйонів українців отримують державні послуги онлайн на порталі Дія” (30 April 2026).; Medvedenko, “Electronic Governance in Ukraine: Analysis of Practical Results and Systemic Deficiencies” (2026).

ENTSO-E, “Commercial Exchanges of Electricity with Ukraine/Moldova to Start on 30 June” (28 June 2022).; ENTSO-E, “TSOs Launch New Process to Calculate Net Transfer Capacity at the Borders of Ukraine and Moldova” (18 June 2025).; IEA, Policy Options to Accelerate Distributed Solar PV in Ukraine (2025).; World Bank, “Updated Ukraine Recovery and Reconstruction Needs Assessment Released” (23 February 2026).

IEA, Empowering Ukraine Through a Decentralised Electricity System (2025).; IEA, “A pre-winter assessment – Ukraine’s Energy Security” (2025).

rather than realised long-term integration effects. These limitations mean that the article should be read as a structured policy analysis identifying plausible and observable mechanisms, not as a causal impact evaluation.

References

- Energy Community Secretariat. 2024. Ukraine Energy Support Fund: 2024 Annual Report. Vienna: Energy Community Secretariat.
- Energy Community Secretariat. 2025. “Ukraine Pushes EU Energy Reforms and Interconnections.” Energy Community Secretariat.
- Energy Community Secretariat. 2026. “Q1 2026 Report of Ukraine Energy Market Observatory.” Vienna: Energy Community Secretariat. Published 11 June 2026.
- Energy Community Secretariat. 2026. “Ukraine Advances Electricity Market Integration with the European Union.” Energy Community Secretariat.
- European Bank for Reconstruction and Development. 2024. Transition Report 2024–25: Ukraine. London: EBRD.
- European Bank for Reconstruction and Development. 2024. “EBRD Commits New Funding and Support for Ukraine at Recovery Conference.” London: EBRD.
- European Bank for Reconstruction and Development. 2024. “Supporting Ukraine’s Private Renewable Energy Industry.” London: EBRD.
- European Commission. 2019. The European Green Deal. Brussels: European Commission.
- European Commission. 2022. REPowerEU Plan. Brussels: European Commission.
- European Commission. 2022. “Digitalising the Energy System – EU Action Plan.” COM(2022) 552 final. Brussels: European Commission.
- European Commission. 2024. Commission Implementing Decision of 10 June 2024 on the Financing of Non-Repayable Support to the Ukraine Plan under Pillar I of the Ukraine Facility. Brussels.
- European Commission. 2024. European Innovation Scoreboard 2024: Country Profile Ukraine. Brussels.
- European Commission. 2024. Strategic Orientations of the Ukraine Investment Framework. Brussels.
- European Commission. 2024. Supporting Ukraine through Digital. Directorate-General for Communications Networks, Content and Technology.
- European Commission. 2024. Ukraine Plan. Brussels.
- European Commission. 2024. Ukraine Report 2024. Directorate-General for Neighbourhood and Enlargement Negotiations.
- European Commission. 2024. “2 Years Since Ukraine and Moldova Synchronised Electricity Grids with EU.” Directorate-General for Energy.
- European Commission. 2025. Ukraine Report 2025. Brussels: European Commission.

- European Commission. 2025. “EU and Ukraine Deepen Cooperation on Cyber Security at 4th Cyber Dialogue.” Directorate-General for Communications Networks, Content and Technology.
- European Commission. 2026. Ukraine’s Path towards EU Accession. European Commission. Last reviewed 21 August 2026.
- European Network of Transmission System Operators for Electricity (ENTSO-E). 2022. “Commercial Exchanges of Electricity with Ukraine/Moldova to Start on 30 June.” 28 June 2022.
- European Network of Transmission System Operators for Electricity (ENTSO-E). 2025. “TSOs Launch New Process to Calculate Net Transfer Capacity at the Borders of Ukraine and Moldova.” 18 June 2025.
- European Parliament and Council of the European Union. 2021. Regulation (EU) 2021/694 establishing the Digital Europe Programme. Official Journal of the European Union.
- European Parliament and Council of the European Union. 2024. Regulation (EU) 2024/792 establishing the Ukraine Facility. Official Journal of the European Union.
- European Union Delegation to Ukraine / EU4Ukraine. 2025. “European Union Supports Ukraine’s Digital Path to the EU: DT4UA Project Results.” EU4Ukraine.
- International Energy Agency. 2024. Renewables 2024. Paris: IEA.
- International Energy Agency. 2024. Ukraine’s Energy Security and the Coming Winter. Paris: IEA.
- International Energy Agency. 2025. Empowering Ukraine Through a Decentralised Electricity System: A Roadmap for Ukraine’s Increased Use of Distributed Energy Resources towards 2030. Paris: IEA.
- International Energy Agency. 2025. Policy Options to Accelerate Distributed Solar PV in Ukraine. Paris: IEA. Published 4 December 2025.
- International Energy Agency. 2025. Ukraine’s Energy Security. Paris: IEA.
- International Monetary Fund. 2024. Ukraine: Second Review under the Extended Fund Facility Arrangement. Washington, DC: IMF.
- Larin, Stanislav. 2026. “Analysis of the Dynamics of Citizen Engagement in the Use of Digital Public Services in Ukraine under the Conditions of Digital Transformation of Public Administration.” Public Administration and Regional Development. DOI: 10.34132/pard2026.32.15.
- Makarenko, P. O. 2025. “Digital Transformation of Public Services: History of the Creation of the ‘Diia’ Platform and Comparative Analysis of International Analogues (2019–2022).” Studies in History and Philosophy of Science and Technology 34(1). DOI: 10.15421/272515.
- Medvedenko, Ihor. 2026. “Electronic Governance in Ukraine: Analysis of Practical Results and Systemic Deficiencies.” Philosophy and Governance 3(19). DOI: 10.70651/3041-248X/2026.3.01.

- Ministry of Climate and Environment of Poland. 2025. “Polsko-ukraińskie rozmowy o bezpieczeństwie energetycznym.” 13 February 2025.
- Ministry of Digital Transformation of Ukraine. 2024. Strategy for the Digital Development of Innovations in Ukraine until 2030. Kyiv.
- Ministry of Digital Transformation of Ukraine. 2024. White Paper on Artificial Intelligence Regulation in Ukraine. Kyiv.
- Ministry of Digital Transformation of Ukraine. 2025. “Держава без черг і паперів: уже 23+ мільйони українців користуються Дією.” 8 October 2025.
- Ministry of Digital Transformation of Ukraine. 2026. “7 мільйонів українців отримують державні послуги онлайн на порталі Дія.” 30 April 2026.
- Ministry of Digital Transformation of Ukraine. 2026. “Вже 24 мільйони українців обрали Дію: державні послуги в кілька кліків.” 16 March 2026.
- Ministry of Digital Transformation of Ukraine. n.d. “Electronic Interaction System Trembita.” Kyiv.
- Ministry of Digitalisation of Poland. 2025. “Polska i Ukraina wzmacniają współpracę cyfrową.” 25 March 2025.
- Ministry of Energy of Ukraine. 2024. Energy Strategy of Ukraine until 2050. Kyiv.
- Ministry of Research, Innovation and Digitalisation of Romania. 2024. “Ministers Bogdan Ivan and Mykhailo Fedorov Signed the Agreement on Electronic Communications and Cooperation in Digitalisation and Cybersecurity.” 5 January 2024.
- Naftogaz Ukraine. 2025. “Ukrtransgaz commences new gas storage injection season.” 21 April 2025.
- OECD. 2024. Digitalisation for Recovery in Ukraine. Paris: OECD Publishing.
- OECD. 2024. Enhancing Resilience by Boosting Digital Business Transformation in Ukraine. Paris: OECD Publishing.
- OECD. 2026. Public Governance Review of Ukraine. Paris: OECD Publishing.
- Rabinovych, Maryna. 2024. “EU Enlargement Policy Goes East: Historical and Comparative Takes on the EU’s Rule of Law Conditionality vis-à-vis Ukraine.” *Hague Journal on the Rule of Law* 16: 715–737. DOI: 10.1007/s40803-024-00223-6.
- United Nations Development Programme. 2024. Digital Transformation and Recovery in Ukraine. Kyiv.
- United Nations Development Programme. 2024. Updated Ukraine Recovery and Reconstruction Needs Assessment. Kyiv.
- Winkler, Christoph, Kristina Dabrock, Serhiy Kapustyan, Craig Hart, Heidi Heinrichs, Jann Michael Weinand, Jochen Linßen, and Detlef Stolten. 2024. “High-Resolution Rooftop-PV Potential Assessment for a Resilient Energy System in Ukraine.” Working paper.

World Bank. 2025. Ukraine Fourth Rapid Damage and Needs Assessment (RDNA4): February 2022–December 2024. Washington, DC: World Bank.

World Bank. 2026. Ukraine Fifth Rapid Damage and Needs Assessment (RDNA5): February 2022–December 2025. Washington, DC: World Bank.

World Bank. 2026. “Updated Ukraine Recovery and Reconstruction Needs Assessment Released.” 23 February 2026.